1 SCREW FASTENER IN MULTIPLE FLOOR TRUSS AND WOOD-TO-WOOD SHEAR CONNECTION

This application is a second continuation-in-part of pending application serial number 09/487,981, filed January 20, 2000 which was based on U.S. Ser. No. 08/920,417 now U.S. 6,109,850 granted Aug. 29, 2000. The first pending continuation-in-part application is serial number 09/692,417 filed October 18, 2000.

Background of the invention

In regions of the country subject to earthquake and hurricane events, it is becoming increasingly common to provide metal straps and anchors for affixing wood frame structures to their concrete foundations. For many years manufacturers such as Simpson Strong-Tie Company, Inc. have designed holdowns for use with bolts. (see Simpson catalog, January 1, 1996 pages 14 and 15 which illustrates holdowns such as HD2A covered by U.S. Patent 4,665,672). These holdowns are very effective, but their load rating is affected by the material which must be drilled out of the wood studs in order to receive the stud bolts which range in diameter from 5/8" up to 1". Moreover, some undesirable looseness is inherent in the connection by contractors who may inadvertently overdrill the bolt holes, or simply by the fact that wood shrinkage occurs after installation of the bolts.

The use of nails instead of bolts in holdowns has greatly reduced the shrinkage and looseness problem of bolts and has led to the development of strap holdowns as illustrated on pages 20, 22, and 23 e.g. of the Simpson catalog supra, (see e.g. U.S. 5,150,553.) The problem with holdowns which use nails is the fact that they must be very long to accommodate the many nails that are required. See e.g. Simpson catalog page 23 in which the HPAHD22-2p requires 23 -16d nails and may be 22" to 42" in length. Many contractors now use nailing guns to drive the nails, but for the person who does not have a nailing gun, the prospect of driving 23 nails for each strap holdown means the expenditure of a great deal of energy driving the nails.

With the increasing use of powered drills, the feasibility of using wood screws as fasteners instead of nails and bolts is now a reality. The problem with screws, particularly for large loading in shear is that standard screws

have several weaknesses. First, it was found that the heavy duty power drivers snapped the heads off a high percentage of standard screws before the clutch disengaged the drive at the end of the driving cycle when the head abruptly reached the immovable sheet metal connector plate. Second, those screws which had adequate unthreaded shank portions to resist the large shear loads, split the wood upon installation or shortly thereafter because the diameters of the unthreaded portions were larger than the bore made by the threaded portion of the screw. Third, adequate self drilling features were difficult to find in large size wood screws. Finally, existing screw fasteners with unthreaded portions adjacent the head which had smaller diameters to prevent wood splitting, were too loose. Looseness in standard screw fasteners between the unthreaded shank and the side of the bore hole which are subject only to pull out, is not a problem. Looseness, between the unthreaded shank portion and the side of the bore hole is a major problem when the screw fastener is subject to shear loads; particularly when the shear loads are cycling loads as they are in earthquakes and hurricanes. In such situations, each reversal of the shear loading tends to widen the bore opening until major loosening occurs and now the loads are impact loads which endanger the structure due to wood splitting.

Floor Trusses

In the floor truss industry, occasions arise when either the uniform load or a concentrated load exceeds the capacity of a single truss. This requires use of a double truss by placing two side-by-side and connecting them so that a portion of the excess load can be transferred from one truss to the other. One such example is described in Loeffler, U.S. 5,653,079 wherein a sheet metal bracket is described which is attached to the wood portions of the truss by screw or nail fasteners. It has been found by tests that load transfer from one truss to the other is diminished due to the inherent looseness of the bracket connection permitting slip between the trusses as load is applied.

Further, such brackets are relatively expensive, time consuming and difficult to install. Most brackets must be installed before the trusses are "in place".

Because the prior brackets have an inherent looseness and because the loads carried by the two trusses are different, the trusses tend to deflect measurably different distances .

Finally, because prior art sheet metal brackets require several inches of truss surface area for installation , it is not always convenient or desirable to use such brackets.

Another way to join wood trusses is by preboring and bolting. The problem with boring openings is the loss of wood cross section and the inability to obtain and maintain a close fit between the bore walls and the bolts.

<u>Summary of the invention</u>

This application describes a wood screw which solves the aforesaid problems. First, a higher strength steel was used in the wood screw of the present invention.

Second, the wood screw of the present invention is formed with a cutting means at the entering end so that bore holes need not be predrilled.

Finally, the major problem of looseness between the sides of the fastener and the bore hole has been solved by the use of a knurled section which functions in a unique manner described herein below.

The use of the wood screw of the present invention solves the problems introduced by bolts by eliminating the need to predrill large openings in the wood which weaken the wood member in tension as introduced by earthquake and hurricane loadings.

The use of the wood screw of the present invention solves the problem introduced by nails by enabling the strap connection to the wood frame to be significantly reduced in length thus saving in metal costs and installation problems.

The wood screw of the present invention is primarily for connecting wood structural members to sheet metal connectors in shear, but may also be used with heavy metal members or even wood to wood connections.

Floor Trusses

This application is specifically directed to the use of the special knurled screws of the present invention in joining the top and bottom wood chords and other truss members in multi-ply wood floor trusses. Such a connection

obviates the problems formerly experienced in joining multi-ply wood trusses by boring bolt openings and inserting bolts, or connecting the trusses with metal brackets.

Such a procedure also obviates the problems of using sheet metal connectors which are expensive to make and even more expensive to install. Multi-ply trusses joined by screws of the present invention, far out perform multi-ply trusses joined by sheet metal connectors in sharing uniform loads or fixed loads and especially through events such as earthquakes and hurricanes where there is a cyclical loading of the truss which tends to loosen prior art sheet metal bracket connections.

An advantage of the present invention is that screws can connect the trusses before or after the trusses are "in place".

A further advantage is that the trusses can be connected using standard construction equipment.

A still further advantage is ease with which the screws can be installed. A standard power drill can install a few screws much more quickly than having to pound several nails at different angles to connect a sheet metal bracket requiring 10 or more nails or short screws. Because of the different angles or space limitations, it is not always possible to install all of the nails or screws in the sheet metal bracket with power tools.

The most significant advantage of the present invention over the prior art is the fact that the load transfer rate is significantly greater than with prior art sheet metal connectors.

As a direct result of the greatly improved load transfer rate, and because the screw connection of the present invention avoids most of the looseness of the prior art sheet metal brackets, the differential deflection performance is greatly improved.

The logistics of transporting, storing, and installing screws is a great deal easier than carrying around and storing bulky boxes of sheet metal brackets as opposed to a bag or boxful of screws.

Finally, the present screw connection can be used to install, top chords only, bottom chords only, webs only or vertical members only which is not always possible with prior art sheet metal brackets.

Brief Description of the Drawings

FIG. 1 is a side elevation view of a wood screw which is representative of one embodiment of the present invention:

FIG. 2 is an enlarged scale, partial central sectional view of the fastener shown in FIG. 1 in operative association with a portion of a wood structural member and a portion of a sheet metal member. Portions of the wood screw have been cut to indicate portions of the axial length of the wood screw have been removed so that the wood screw may meet the drawing paper restrictions. The upper portion of the wood screw is only partially in cross section to clarify the details of the invention. In this view, the pointed end portion 7 and substantially all of the threaded shank portion 8 has moved through the opening in the sheet metal member 5 and entered the wood structural member 2. The knurled section 14 has not yet entered the bore opening 3.

FIG. 3 is a partial central sectional view of the wood screw shown in FIGS. 1 and 2 in which the knurled portion 14 has just passed through the opening in the sheet metal member 5 and has entered the wood structural member 2. A portion of the knurled means 14 has been removed to show how the portions between the knurls fill up with mashed wood fibers from the wood structural member.

FIG. 4 is a partial central sectional view of the wood screw shown in FIGS 1, 2 and 3 in which the wood screw is fully installed.

FIG. 5 is a side cross sectional view of the screw shown in FIG. 1 installed in a typical installation. A foundation to frame sheet metal connector is illustrated connecting a wood frame member to a concrete foundation..

FIG. 6 is a cross sectional view of another use of the wood screws of the present invention.

Fig. 7 is an example of a portion of a typical floor truss profile of two trusses in side by side relationship joined by screws of the present invention. The trusses are known in the trade as "Two-Ply 4x2 Floor Trusses". In such a truss, the 2 x 4 top and bottom chords are laid flat instead of on edge. The load is applied normal to the side of the 2 x 4 instead of normal to the edges of the 2 x 4's. The web and vertical members of the truss could be metal members, but are here shown as wood 2x4's which are laid flat instead of on edge in the same manner as the top and bottom chords.

Fig. 8 is a cross section of an enlarged portion of the truss chords and web members of the two side-by-side trusses illustrated in Fig. 7 taken along line 8 - 8 of Fig. 7 illustrating a typical installation of screws of the present invention having a self boring cutting point and a dull knurled portion.

Fig. 9 is a cross section of an enlarged portion of the truss chords and web portions of the two side-by-side trusses illustrated in Fig. 7 taken along line 8-8 of Fig. 7. Figure 9 illustrates a first bore formed in the chords of the side-by-side floor trusses illustrated in Fig. 7 taken along line 8-8 of Fig. 7. In this example, the first bore is the first step in the installation of standard lag screws as illustrated in Fig. 11.

Fig. 10 is a cross section of an enlarged portion of the truss chords and web portions of the two side-by-side trusses illustrated in Fig. 7 taken along line 8-8 of Fig. 7. Figure 10 illustrates a second bore formed in the chords of the side-by-side floor trusses illustrated in Fig. 7 taken along line 8-8 of Fig. 7. In this example, the second bore is the second step in the installation of standard lag screws as illustrated in Fig. 11.

Fig. 11 is a cross section of an enlarged portion of the truss chords and web portions of the two side-by-side trusses illustrated in Fig. 7 taken along line 8-8 of Fig. 7. Figure 11 illustrates a standard lag screw installed in the first and second bores illustrated in Figs. 9 and 10.

Fig. 12 illustrates a screw of the present invention joining two wood members in an edge to edge configuration.

Fig. 13 illustrates another form of the invention in which a standard wood screw is used to join multiple side by side trusses having wood members in an edge to edge configuration

Description of the Invention

Referring to the drawings, and in particular FIGS. 1 and 6, the wood screw 1 of the present invention is adapted to hold a wood structural member 2 formed with a first bore 3 to a sheet metal member 5 or a first wood member 101 to a second wood member 102 in shear.

While the wood screw 1 of the present invention has excellent pull out value, the design is primarily directed to resisting shear forces. Three examples of environments in which the wood screw of the present invention is subject to shear forces are illustrated in the drawings.

Referring to FIG. 5, wood screw 1 connects a retrofit holdown device 36 to a wood sill member 37 resting on concrete foundation 38. Wood screw 1 is inserted through opening 45' in sheet metal member 5'. A bolt 39 connects the retrofit holdown device 36 to foundation 38. Arrow 40 represents an upward force exerted on wood sill member 37 which may occur during either an earthquake or a high wind force such as a hurricane. Such an upward force as represented by arrow 40 exerts a shear force along shear plane 41 as shown in FIG. 5. As may be understood, a force acting in the direction of arrow 42 exerts a pull out force on wood screw 1.

Another example of shear forces exerted on wood screws 1 of the present invention is illustrated in FIG. 6. Here, a sheet metal holdown 43 is connected to a foundation 38' by anchor bolt 39' and securely holds wood sill member 37' to foundation 38'. Wood screws 1 of the present invention are inserted through openings 45" in sheet metal member 5" of holdown 43 into wood stud member 46. Arrow 40' represents an upward force imposed by an earthquake or high winds such as a hurricane which imposes a shear load along shear plane 41'. Arrow 42' represents a horizontal load imposed by an earthquake or high winds such as a hurricane which imposes a pullout force on wood screws 1.

Referring now in detail to the wood screw 1 of the present invention as most clearly shown in FIGS. 1 and 2, the screw 1 includes; a shank 6 having an overall length 44 ; a pointed end portion 7 formed on an entering extremity of the shank 6; the shank 6 having a threaded shank portion 8 having thread convolutions 9 with an outer diameter 10 greater than the diameter of the first bore 3 and beginning at a first point 11 adjacent the pointed end portion 7 and extending axially along the periphery of the shank 6 to a second point 12 and adapted to form and engage threads 13 in the wood structural member 2; knurled means 14 formed in a portion of the shank 6 having a first point 15 adjacent the second point 12 of the threaded shank portion 8 and extending axially along the shank 6 to a second point 16 and having an outside diameter 17 generally equal to the outer diameter 10 of the thread convolutions 9 in the threaded shank portion 8 and having an inside diameter 18 (see FIG. 4) less than the outside diameter 17 of the knurled means 14; the shank 6 having an unthreaded shank portion 19 having a diameter 20 generally equal to the outside diameter 17 of the knurled means 14 and having a first point 21 adjacent the second point 16

of the knurled means 14 and extending axially along the shank 6 and terminating at a second point 22; the knurled means 14 being adapted for mashing over and radially outwardly without severing a substantial proportion of the wood fibers of the inner portions 23 of the threads 13 formed in the wood structural member 2 forming an annular zone 55 of mashed and severed, as well as unsevered wood fibers having an outer diameter 56 greater than the diameter 20 of the unthreaded shank portion 19 and forming a tight fit between the unthreaded shank portion 19 and the annular zone 55 of mashed and severed, as well as unsevered, wood fibers of the wood structural member 2; and a head 26 integrally connected to the shank 6 adjacent the second point 22 of the unthreaded shank portion 19.

The wood screw of the present invention need not have a threaded pointed end or a means for cutting its own bore and threads in a wood member if a bore is predrilled. It is highly advantageous, however, to form a wood screw 1 which will drill its own bore and threads in a wood member since predrilling a bore is expensive in installation time. Power drivers to drive large diameter wood screws are now widely available and thus, referring to FIGS. 1 and 4, a preferred form of the wood screw 1 of the present invention adapted to hold a wood structural member 2 to a sheet metal member 5 in shear includes; a shank 6; a pointed end portion 7 formed on an entering extremity of the shank 6 having a plurality of convolutions 27 and a recess 28 providing a cutting edge 29 adapted for forming a first bore 3 having a diameter 4; and the shank 6 having a threaded shank portion 8 having thread convolutions 9 similar to the thread convolutions 27 on the pointed end portion 7 with an outer diameter 10 greater than the diameter 4 of the first bore 3 and beginning at a first point 11 adjacent the pointed end portion 7 and extending axially along the periphery of the shank 6 to a second point 12 and adapted to form and engage threads 13 in the wood structural member 2. All other elements of the preferred form of wood screw 1 are identical to the previously described wood screw and for purposes of brevity are not repeated.

Referring to FIG. 3, knurled portion 14 may be double knurled in a cross hatched pattern or have single straight knurls formed at an angle to the axis of the screw. It has been found, however, that straight knurls 30 (see

FIG. 2) having a dull edge 47 and valleys 48 between the dull edges 47 perform satisfactorily.

It has also been found that where the axial length 31 (see FIG. 1) of the knurled means 14 is substantially less than the axial length 32 of the unthreaded shank portion 19 satisfactory results are obtained.

Providing wood screw 1 with an unthreaded portion 19 reduces the power requirements to drive the screw and maximizes the amount of metal at the shear plane 41 and 41' (see FIGS. 5 and 6) adjacent the head 26 of the wood screw 1. Accordingly, the axial length 32 of the unthreaded portion 19 is preferably substantially less than the axial length 33 of the threaded portion 8.

To accommodate the power driven tool and provide maximum gripping power, the head 26 is preferably hexagonal in shape.

The head 26 is preferably formed with an integral washer 35 for several reasons. First, the upper surface 49 serves as an abutment for the nose of the power tool. Second, the under surface 50 of washer 35 provides surface area to prevent the power drill from inserting the hex head 26 through opening 45. Finally, under surface 50 frictionally engages sheet metal member 5 and the increased friction of the washer 35 against sheet metal member 5 imposes greater resistance which may cause slip clutches in the power tool to operate and stop the driving of the wood screw 1.

Operation of the wood screw of the present invention is as follows. Referring to FIG. 2, the power tool nose is inserted over hexagonal head 26 with a portion of the power tool nose in abutment with upper surface 49 of washer 35. The point 51 of wood screw 6 is then inserted through opening 45 in the sheet metal member 5 and rotation of the wood screw 6 is begun. Cutting means as formed by edge 29, recess 28, and curved surface 52 immediately begins to form first bore 3 (see FIG. 4) and to cut threads 13 into wood member 2. The cutting means on the wood screw 6 of the present invention is well known in the industry and is similar to the cutting means disclosed in Stern, U.S. 2,871,752.

Thread convolutions 27 on pointed end portion 7 which are part of cutting edge 29, cut threads in wood structural member 2 which enable thread convolutions 9 on threaded shank portion 8 to easily follow into the wood. As stated above, threads 13 are formed in the wood structural

member having inner portions 23 extending to the outer diameter 4 of first bore 3.

Referring to FIG. 3, as the tapered entering portion 54 (see FIG. 3) of knurled portion 14 of wood screw 1 reaches outer face 53 of wood structural member 2, the dull edges 47 of each knurl 30 engage inner portions 23 of threads 13. It is preferable to taper the entering portions 54 of the knurled means 14 as shown in the drawings to lessen the shock as the knurls 30 strike the inner portions 23 of threads 13. Referring to FIG. 2, tapered entering portion 54 is bounded by lower bevel end 60 and upper bevel end 59. This is especially important since as previously stated edges 47 of the knurls 30 are dull and thus there is a greater resistance encountered by the wood screw 1 as it proceeds through the wood structural member 2.

The function of the dull edges 47 of knurls 30 is to bend the inner portions 23 of threads 13 in the structural wood member so as to mash rather than to sever a substantial portion of the wood fibers of the structural wood member. These bent over and mashed wood fibers as well as the severed wood fibers are illustrated in FIGS. 3 and 4 and are indicated generally by the number 55 which represents an annular zone of mashed and severed, as well as unsevered, wood fibers. The annular zone of mashed wood fibers 55, as seen when wood screw 1 is fully seated, is bounded by the space outboard of diameter 20 of unthreaded shank portion 19 and outer diameter 56 of the mashed fiber annular zone. Annular zone of mashed wood fibers 55 as seen in FIG. 4 extends from outer face 53 of wood structural member 2 to penetration point 61 (see FIG. 4) of upper bevel end 60 of knurled means 14 (see FIG. 2).

As the knurled means 14 proceeds into the wood structural member 2, the valleys 48 between the dull edge ridges 47 of knurls 30 fill with the unsevered fiber ends as well as severed wood fibers of the mashed over inner portions 23 of threads 13 and loose cuttings from the cutting edge 29 on the pointed end portion 7 of the wood screw 1. This filling of the valleys 48 in the knurls 30 further reduces the cutting or severing of the wood fibers as the knurl means 14 continues through the wood structural member 2.

The effects of the previously described mashing of the wood fibers is shown in FIG. 4. In this view, the wood screw 1 has been fully inserted into

the structural wood member 2 and is now in place to resist shear forces acting between sheet metal member 5 and the wood structural member 2. The result of the wood mashing of inner portions 23 of threads 13 of the wood structural member 2 is that the mashed wood fibers form an annular zone 55 which tightly fills any space between the outer diameter 20 of unthreaded shank portion 19 and the outer diameter 56 of the mashed fiber annular zone 55. This annular zone 55 of tightly packed mashed wood fibers mixed with some cuttings from cutting edge 29 on the pointed end portion 7 of the wood screw 1 prevents essentially all looseness between the wood screw 1 and the structural member 2. This tight fit of the wood screw 1 with the structural wood member serves to increase the wood screws resistance to lateral displacement which contributes to the increase in shear resistance along the shear planes 41 and 41' as seen, e.g. in FIGS 5 and 6.

By sizing the knurled means 14 with an outside diameter 17 generally equal to the outer diameter 10 of the thread convolutions 9 in the threaded shank portion 8 and generally equal to the diameter 20 of the unthreaded shank portion 19, wood splitting as the unthreaded shank portion enters the wood structural member 2 is obviated.

As an example, the wood screw 1 of the present invention may be manufactured from 1022 steel (SAE Grade 5) with a finish coat of zinc and dichromate. The hex washer head 26 may be 0.375 inch (9.5 mm). The self drilling tip or pointed end portion 7 may be a Type-17, and allows for driving without lead holes. Lead holes, however, may be required by the local building official, depending on wood type and moisture content in accordance with Section 2339.112 of the Code of International Conference of Building Officials (ICBO).

Some typical dimensions of wood screws of the present invention having an overall shank length 44 measured from the underside 50 of washer 35 to the point 51 ranging from 1 1/2" to 3 1/2" are as follows: The length 33 of the threaded section 8 may vary from 7/8" to 3 1/4" while the axial length 31 of the knurled section 14 remains at a constant .250". and the length 32 of the unthreaded shank portion 19 varies with the length of the wood screw 1. For example, where the shank length is 1 1/2", the unthreaded shank portion 19 may be 5/8" whereas an overall shank length 44 of 3 1/2" may have an unthreaded shank length 19 of 1 1/4". Outer

diameter 10 of thread convolutions 9 may have a diameter of 0.259 - 0.250" and an inner diameter of 0.187" to 0.183".

While the wood screw of the present invention is shown in FIGS. 5 and 6 for use with holdown connectors used in attaching wood frame buildings to concrete foundations, the wood screw as above described may be used anywhere that wood screws of the size and type described may be used. The wood screws of the present invention may be used with heavy metal members or wood to wood connections.

Joinder of Trusses

Use of wood trusses or metal trusses having at least one wood chord are common in the construction industry. It is becoming increasingly common for conditions to arise due to loading and other considerations to join two or more trusses side-by-side so that the loading is distributed to the additional truss or trusses. This application is directed to those trusses in which the wood members of the respective chords which are to be joined are in edge-to-edge relationship. An example of such a truss is illustrated in Fig. 7 and is known as a floor truss in which the top and bottom chords 101 and 102 are parallel. This application is not limited to floor trusses, or trusses in which the bottom and top chords are parallel. This application fully applies to trusses, regardless of their type. This application, is however, directed to trusses in which the adjoining truss members to be joined are oriented in an edge to edge relationship. In other words, the wood members are laid flat instead of on edge. Thus the load is applied normal to the side of the wood member such as a 2 x 4 instead of normal to the edge. This edge to edge relationship is shown in Figs 7 - 13.

The prior art system for joining side by side trusses in which the wood members to be joined are edge-to-edge is to use a metal bracket joined to each adjoining wood member. The truss bracket disclosed in U.S. 5,653,079 assigned to United Steel Products Company is one such bracket. Another system is the use of metal angles by Simpson Strong-Tie Company Inc. as illustrated in their catalog at page 95 under the heading L70 Reinforcing Angle. As stated in the catalog; "L70 reinforcing angles may be used in pairs to transfer loads between floor truss plys. As set forth in the Simpson catalog, even under the best conditions, the load transfer rate

equals 40% of the applied load when the applied load is within 2/3 of the span.

The United Steel Products Company patent 5,653,079 does not disclose what percentage of load transfer is attained between adjoining trusses, but Applicant's test show that none of the connector clips used by Simpson's competitors, including United Steel Products Company, would transfer 50% of the applied load to the second truss. It is applicant's belief that this low percentage is due to the looseness of the bracket connection. The bracket joint between the loaded truss and the auxiliary truss could not be made stiff enough to take the spring factor out of the joint. The sloppiness of each joint prevented the trusses from really ever acting as a unit. Since there was too much movement between the side-by-side trusses, they could not get good load transfer.

Since the excess movement between adjacent trusses was observable, and since excess bending is a well known cause of splitting when boards are laid flat, the idea of joining boards with screws did not occur to anyone as a feasible solution. In fact, driving screws through the edges of 2 x 4 wood members at regular intervals would intuitively lead to a greater tendency to split the wood chords. "Outside the box" thinking was clearly called for to find a solution which would substantially improve the abysmal 50% ceiling to load transfer between the loaded beam and an auxiliary beam. Applicant, although he knew of all the aforesaid problems, thought he would try joining edge to edge two by fours with the SDS 1/4 x 6 screws described in U.S. patent 6,109,850. The crude experiment worked amazingly well. Even though the two joined 2 x 4's still bent and ultimately split, applicant knew that a single truss provided a stiffer platform. The test would be whether screws would provide a stiffer joint between two trusses than the existing brackets. Applicant tried an experiment on short trusses with SDS 1/4 x6 screws and it was successful . The experiment, even though crude, yielded a greater than 50% transfer of load from the side-by-side auxiliary truss. This was a greater transfer than others had been obtaining, and this led to full size multiple trusses which confirmed that the load transfer was significantly better than the metal bracket connector approach.

Floor trusses have been successfully tested installing screws as follows:

A. SDS 1/4 x 6 screws in the truss top chord only.

B. SDS 1/4 x 6 screws in the top and bottom chords.

C. SDS 1/4 x 6 screws in a vertical web of the truss.

D. SDS 1/4 x 6 screws in diagonal and vertical webs of the truss.

E. SDS 1/4 x 6 screws at truss mid-panel points.

In addition to increasing he load transfer to auxiliary trusses, the use of screws instead of bracket connectors has the following advantages:

A. Screws can be installed before or after the trusses are "in place". (Most competitor products must be installed before the trusses are "in place".

B. Installation can be performed using standard construction equipment.

C. The differential deflection performance is improved.

D. There are several installation configurations that can be used. (i.e. install SDS 1/4 x 6 screws in top chord only, in bottom chord webs only, in diagonal webs only, and in vertical webs only.

Referring to Fig. 7, a preferred form of the invention is illustrated in which a pair of floor trusses 104 is illustrated having top and bottom parallel wood chords 101 and 103 in which the wood chords are laid flat and the edges of the wood members including chords 101 and 102, vertical member 106 and diagonal members 125 and 125' are joined by fasteners 105.

Referring to Fig. 8, wood screw 1 of the present invention is illustrated joining chords 101 and 102 with edge 107 of chord 101 abutting edge 108 of chord 102. Note that point 51 of wood screw 1 penetrates a substantial distance into wood chord 102, but does not necessarily extend all the way through.

Figures 9, 10 and 11 illustrate another form of the invention. Figure 9 illustrates a first bore 109 drilled through chords 101 and 102 from first edge 110 to second edge 107 of chord 101, and through edge 108 of chord 102 to a point 111 substantially through chord 102.

To attain the necessary tightness of fit for a lag screw 112 as illustrated in Fig. 11, a second bore hole 113 is bored having generally the length of the unthreaded portion 114 of the lag screw 112. Fig. 11 shows lag screw 112 properly installed within chords 101 and 102.

The two lead holes of different diameters recommended for installation of a lag screw in the present application and in most lag screw

installations is adopted from *the* wood design reference book, Design of Wood Structures, Fourth Edition by Breyer, Fridley and Cobeen and page 13.45 is provided in the Information Disclosure Statement.

Also, the following statement is taken from the 1997 NDS (the governing wood design code used in all major U.S. building codes) :

9.1.2 Fabrication and Assembly

9.1.2.1 Lead holes for lag screws shall be bored as follows:

(a) The clearance hole for the shank shall have the same diameter as the shank, and the same depth of penetration as the length of the unthreaded shank.

(b) The lead hole for the threaded portion shall have a diameter equal to 65% to 85% of the shank diameter in wood with G>0.6, 60% to 75% in wood with 0.5<G[0.6, and 40% to 70% in wood with G[0.5 (see Table 9A) and a length equal to at least the length of the threaded portion. The larger percentile in each range shall apply to lag screws of greater diameters.

9.1.2.2 Lead holes or clearance holes shall not be required for 3/8" and smaller diameter lag screws loaded primarily I withdrawal in wood with G[0.5 (see Table 9A), provided that edge distances, end distances and spacing are sufficient to prevent unusual splitting.

9.1.2.3 The threaded portion of the lag screw shall be inserted in its lead hole by turning with a wrench, not by driving with a hammer.

9.1.2.4 Soap or other lubricant shall be used on the lag screws or in the lead holes to facilitate insertion and prevent damage to the lag screw.

The "G" referred to above is the specific gravity (a measure of density). The Table 9A provides these values. The values for Southern Pine, Douglas Fir-Larch and Spruce-Pine-Fir are, respectively, 0.55, 0.49 and 0.36.

Fig. 12 shows still another form of the present invention. In this form, a screw 1 of the present invention having a recess 28 for self drilling a bore hole, a threaded shank portion 8, a dull knurl portion 14 , and unthreaded

shank portion 19 is inserted through boards 115 and 116 from edge 117 of board 115 to distal edge 118 and from edge 119 to a substantial portion within board 116. Since a large enough force 126 applied to boards 115 and 116 would ultimately split one or both boards 115 and 116 at about the level of screw 1 as the boards bent further and further due to load 126., a restraining force to limit bending or some other means illustrated by arrows 127 must be used. Such bending restraints could be springs or limiters which stopped all bending beyond a certain point or some device to limit the force 126 from acting on the boards so that a certain predetermined bending deformation could not be exceeded. Still another form of the invention is illustrated in Fig. 13 in which a standard wood screw 120 having threads 21 throughout a substantial portion of the length of its shank is inserted or driven into the edge 110 of chord 101, through the distal edge 107 of chord 101 and into the edge 108 and through a substantial portion of chord 102 of a truss 104. The wood screw 120 may be either self drilling with a drill point recess 128 or have no drill point, but instead be driven into a predrilled bore.

The screw illustrated in Fig. 13, has only limited use, but nevertheless may be used in some truss applications. The screw 1 illustrated in Figs. 1 - 6 is far superior in its ability to prevent splitting of the wood in an edge driven application and in ease and speed of installation.